UMass Amherst | College of Engineering
Mechanical and Industrial Engineering

Yearlong Senior Capstone Design

Mid-Year Progress Report

Guide Dog Robot 1411

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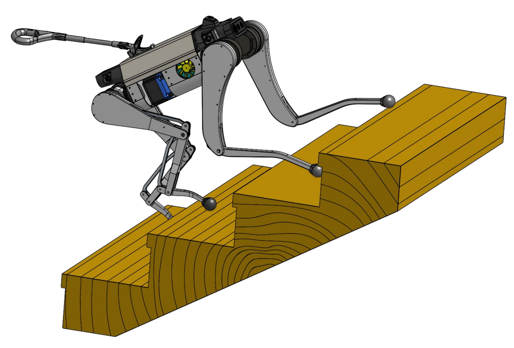
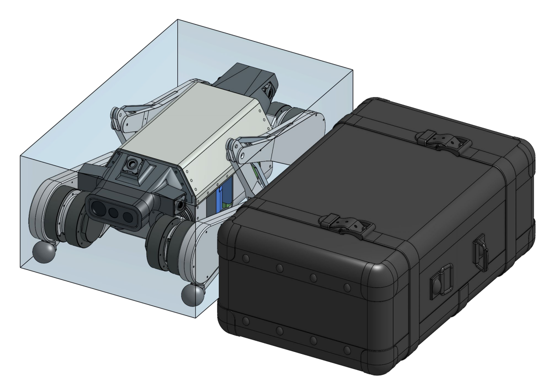
Objective

Design and fabricate the body and legs of a power-efficient, lightweight guide dog robot capable of stair climbing while ensuring a compact body for portability and user-friendliness.

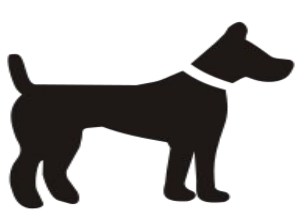


Stair climbing



Portability

Motivation



Guide Dogs

- Training: $40,000 ❌
- Maintenance: $1000/year ❌
- Limited availability ❌

Commercially Available Quadrupeds

- Large scale: Can climb stairs but too big ❌
- Small scale: Can't climb stairs but small enough ❌

Specifications

	Ideal	Marginal
Rise/go [m/m]	0.20/0.25	0.18/0.28
Battery Capacity [Wh]	288	134
Mass [kg]	21.5	25
Storage Volume [m^3]	<0.45	0.45
Operating Temp. [C°]	<55	55

Engineering Standards: ISO 13482, ISO 286, ADA § 504, ASTM B308/B308M-20, ASTM A1018/A1018M-18

Selected Design Concept

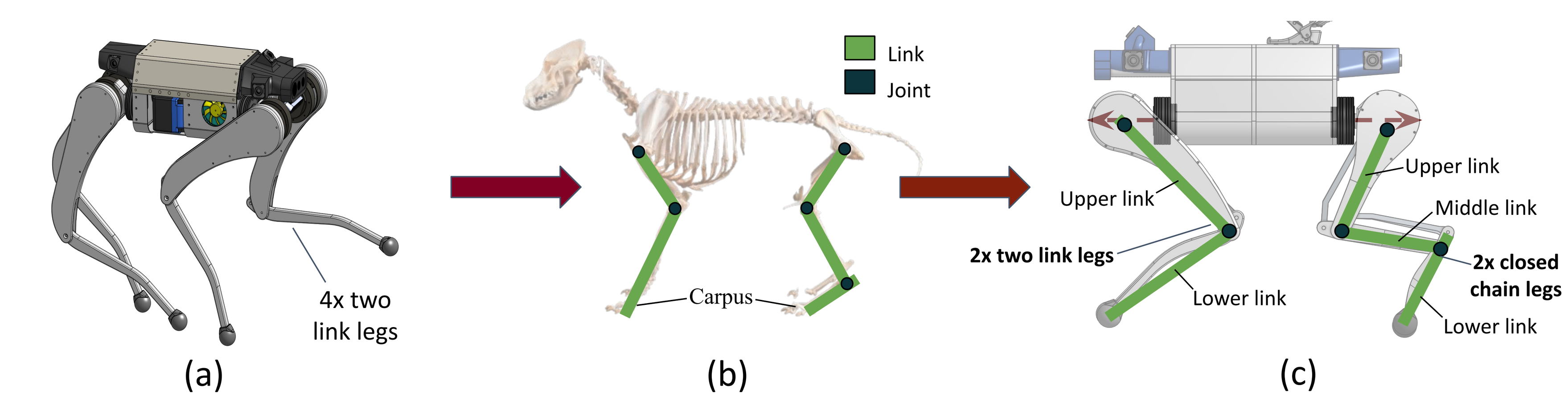


Figure 1: Leg design iterations. (a) Initial two link leg design. (b) Dog anatomy. (c) Bio-inspired leg design.

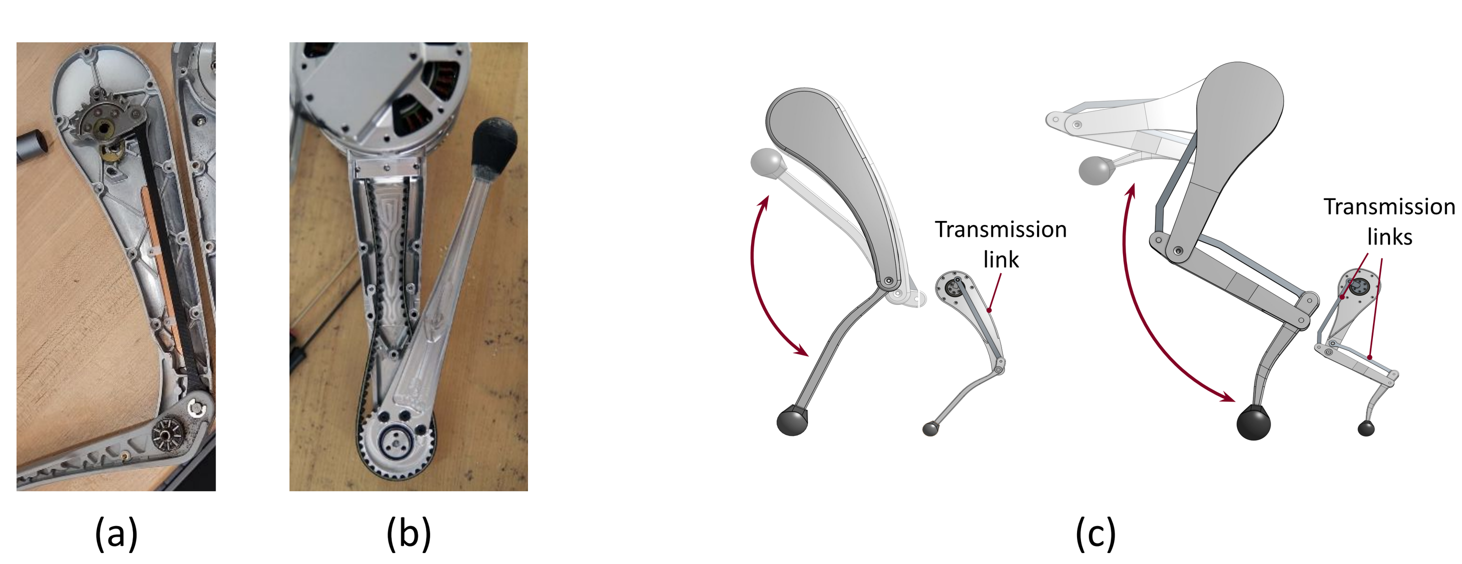


Figure 2: Elbow actuation mechanisms. (a) Parallel link in Go1. (b) Timing belt in Mini Cheetah. (c) Chosen parallel transmission link setup.

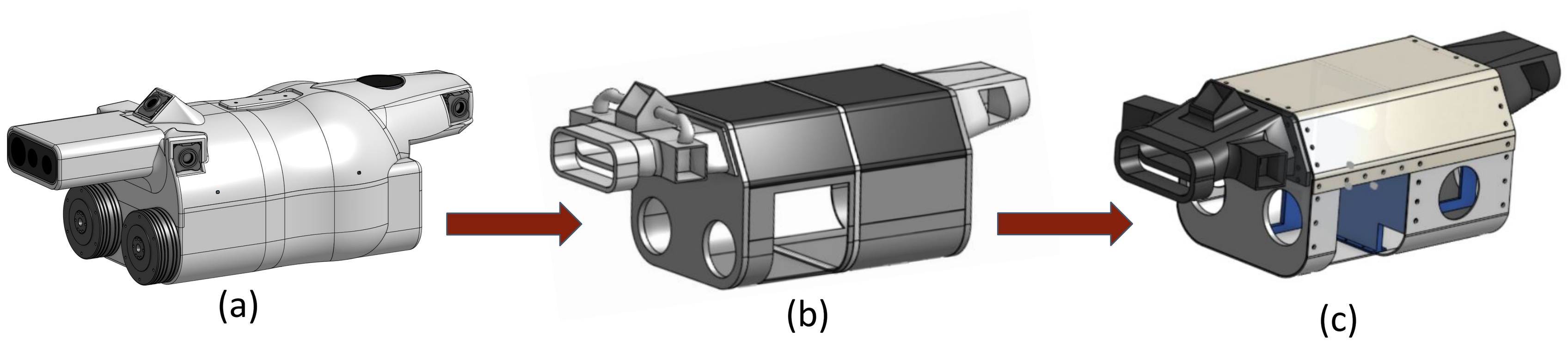


Figure 3: Body design iterations. (a) 3D printed design. (b) Four-piece sheet metal design. (c) Chosen two-piece sheet metal design

Supporting Engineering Analysis

Statics
- Shear/moment diagrams
- Maximum stress

Strength of Materials
- Max deflection
- FEA
- Column buckling
- Material strength

Dynamics
- Forward/inverse kinematics
- Inverse dynamics

Electrical
- Battery life
- Motor control

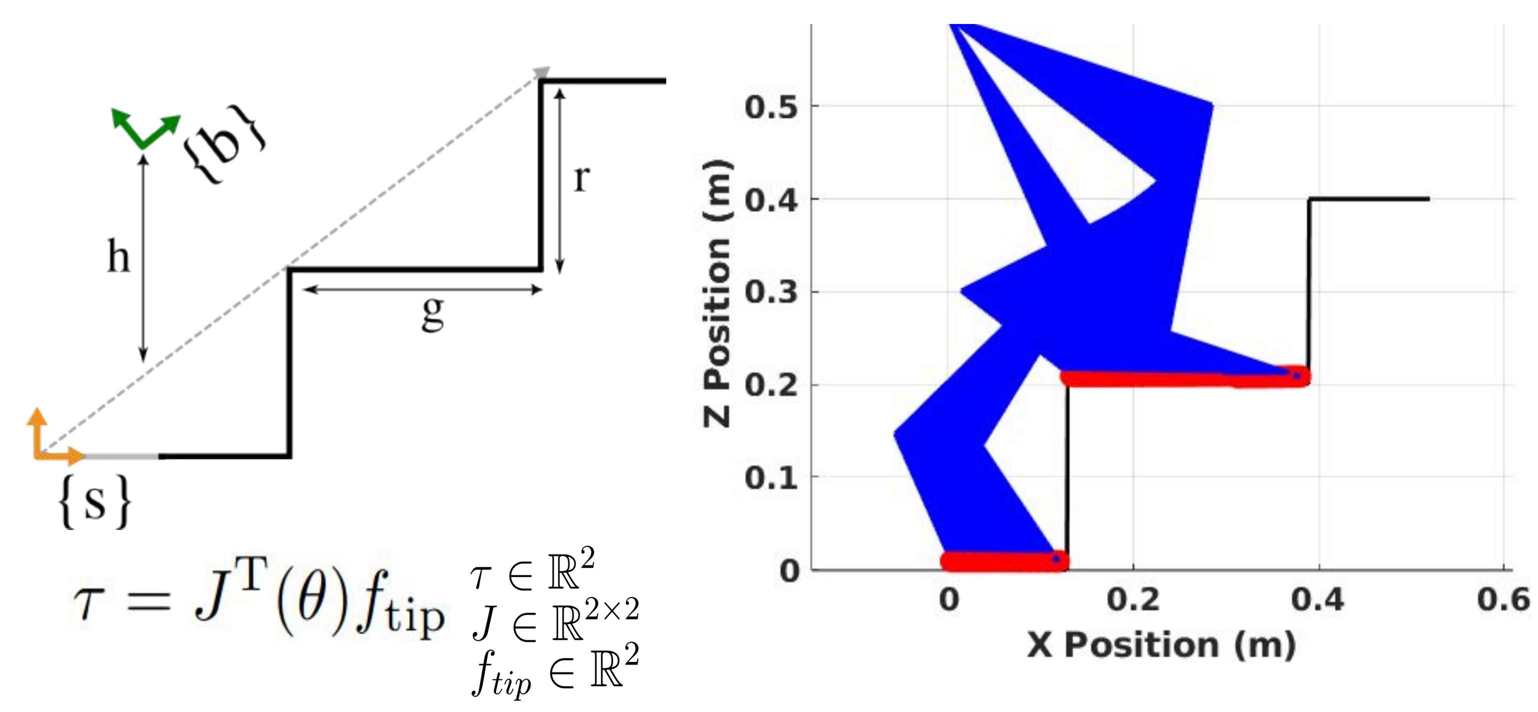


Figure 4. Stair climbing kinematic analysis.

Proof of Concept Implementation

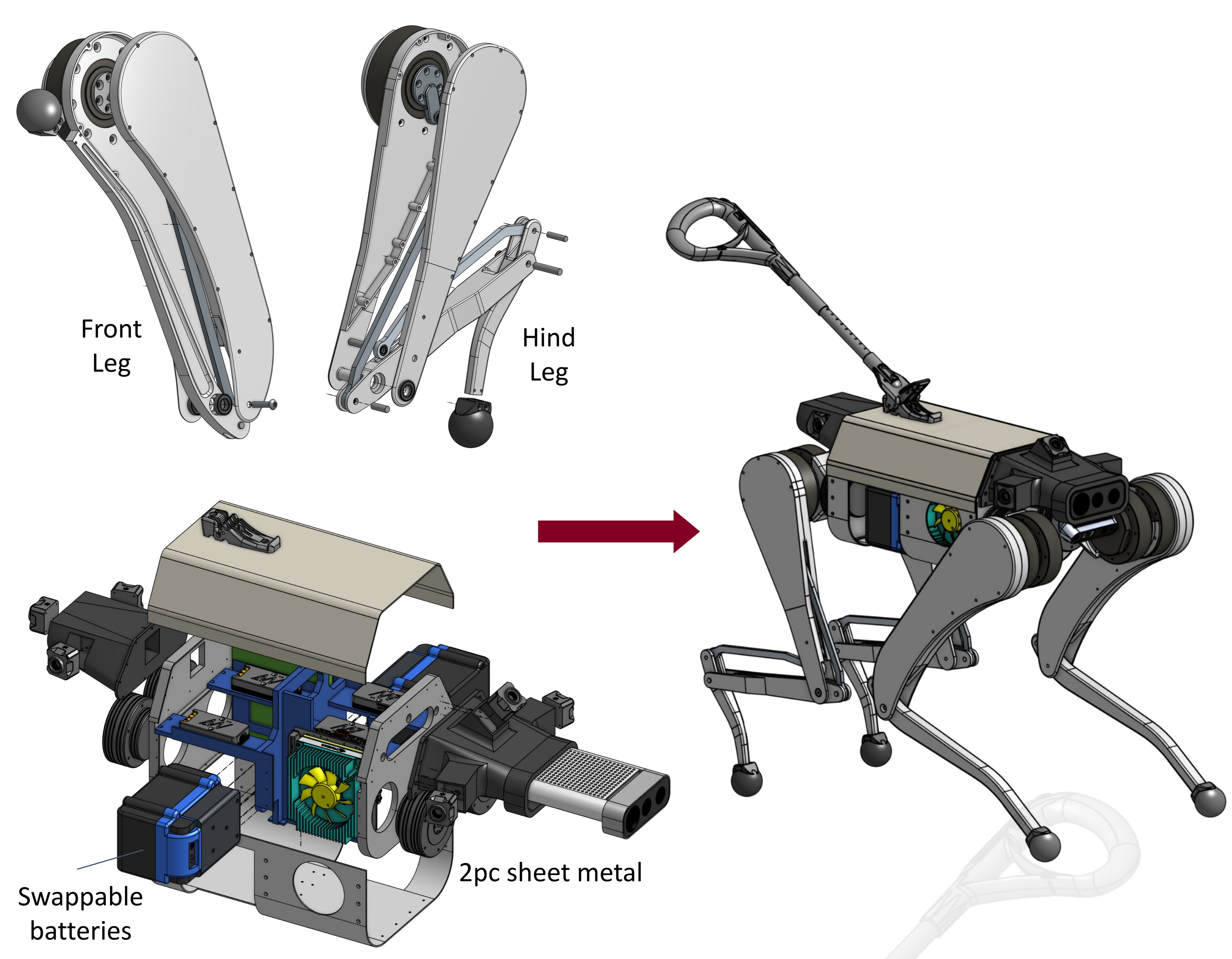


Figure 5: Selected design concept.

Performance Evaluation

- Stair climbing assessment
- Max temperatures of CPUs
- Mass of final assembly
- Battery life under constant use
- Final collapsed dimensions

Project Plan

- **Spring semester project plan:** manufacture prototype
- Self-machine & 3D print simpler parts, camera mounts
- Order complex parts from contract manufacturer
- Setup electronics (motor control, power board, PCB design)

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